

Exceptional service in the national interest



LABS

ACCOMPLISHMENTS

Sandia LabNews
February 2013



To all Sandians:

The annual Labs Accomplishments issue of the *Sandia Lab News* provides a snapshot in time of some of the most significant work performed at the Laboratories over the past year. The accomplishments summarized in this year's issue bring to life the strategic vision expressed in our FY12-FY16 Strategic Plan. Our strategic objectives [see box at right] are our guide as we develop solutions for the nation's most daunting national security challenges.

Among the accomplishments listed here, you'll read about advances we have made in our core mission of ensuring that our nation's ultimate strategic deterrent, our nuclear weapons stockpile, remains safe, secure, reliable, and efficient. You'll find here, too, some striking examples of our success in the areas of computer science, modeling, and simulation, cybersecurity, alternative energy, and the ever-more important area of biotechnology. You'll discover how we've supported our nation's military, including our contributions to the US Army's Advanced Hypersonic Weapon program. You'll read how we've worked with the global community to safeguard at-risk radioactive sources, partnered with China to prevent illicit trafficking in nuclear materials, and collaborated with our counterparts from Russia to explore the peaceful uses of nuclear energy.

Our mission support organizations continue to provide innovative leadership in the areas of ES&H, sustainability, quality, and employee benefits. You can read about many of their latest highlights here.

As you read through these accomplishments, I think you will appreciate the scope of our capabilities as a laboratory. That is all very much by design. As our official Sandia mission statement puts it, "Our unique responsibilities in the nuclear weapons program create a foundation from which we leverage capabilities enabling us to solve complex national security challenges."

Of course, any collection of accomplishments is inevitably incomplete. This one is too. It would take a document many times the size of this publication to convey even a thumbnail description of all the great work accomplished at Sandia over the past year. And this document does not, understandably, include the many, many advances we have realized in areas of national security that are too sensitive for open publication.

I'm sure you'll enjoy looking through this year's Labs Accomplishments issue as much as I have enjoyed doing so. It reminds me, yet again, of why I am so proud to work with such dedicated and talented men and women. It reminds me, once again, of why I am proud to be a Sandian.

Paul Hommert

Sandia President and Laboratories Director



PAUL HOMMERT

Sandia’s Strategic Objectives 2012-2016

- Deliver with excellence on our commitments to the unique nuclear weapons mission
- Amplify our national security impact
- Lead the Complex as a model 21st century government-owned contractor-operated national laboratory
- Excel in the practice of engineering
- Commit to a learning, inclusive, and engaging environment for our people

Values

Sandia has five core values, which are used to inform our daily decisions, shape our performance, and enable us to achieve success as one lab with one national security mission.

We serve the nation by responding to the requests of our customers and by anticipating our country's future needs. We complete our mission even in the face of challenges and ambiguity, and seize every opportunity to "render exceptional service in the national interest."

We deliver with excellence by meeting our commitments, hiring the best, working collaboratively, and committing ourselves to continuous improvement to advance the frontiers of science, engineering, and technology.

We respect each other by cherishing the intellect, skills, diversity, flexibility, and passion of our coworkers. We cultivate the development of all members of our workforce and commend their world-class accomplishments, which enable Sandia's mission.

We act with integrity by living consistently within our principles, by telling the truth, and complying with the law.

We team for great results by sharing a common vision and by fostering an attitude of mutual respect with all our partners. We combine our talents to benefit each other and our customers, working to ensure that everyone gains from our collective achievements.

Vision
On behalf of our nation, we anticipate and solve the most challenging problems that threaten security in the 21st century.

Inside . . .

<i>Nuclear weapons engineering</i>	3, 4	<i>IT, networks, & facilities</i>	9	<i>Global security</i>	12
<i>Weapon facilities and security</i>	4	<i>Supply chain</i>	9	<i>Infrastructure security</i>	12
<i>Product realization</i>	5	<i>Partnerships & alliances</i>	9	<i>Energy</i>	13
<i>Remote sensing</i>	6	<i>Military programs</i>	10	<i>Pulsed power</i>	14
<i>Robotics and engineered safety</i>	6	<i>Homeland security</i>	10	<i>ES&H & security</i>	14
<i>Materials</i>	7	<i>Microelectronics & microsystems</i>	11	<i>Governance, leadership, & management</i>	15
<i>Bioscience</i>	7	<i>HR & finance</i>	11	<i>Community involvement, customer relations, and institutional development</i>	15
<i>Computer & information sciences</i>	8	<i>Engineering sciences</i>	12		



Cover photograph by Randy Montoya

Sandia researchers use advanced computational capabilities to simulate the behavior of weapon components under a variety of conditions.

See more on page 12.

This year's *Labs Accomplishments* publication recognizes some of Sandia's best work during 2012, as submitted by center offices and selected by division offices. Most citations are followed by the numbers of the centers that contributed most directly to the effort described.

The acronym after most of the accomplishments indicate which of Sandia's strategic management units (SMUs) the work most directly supported. The SMU acronyms are:

NW: Nuclear Weapons SMU
 DSA: Defense Systems & Assessments SMU
 IHNS: International, Homeland, & Nuclear Security SMU
 ECIS: Energy, Climate, & Infrastructure SMU
 IMS: Integrated Mission Support SMU
 WFO: Work for Others

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Sandia National Laboratories

Sandia National Laboratories is a multiprogram laboratory operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corp., for the US Department of Energy's National Nuclear Security Administration.

Nuclear weapons engineering

In partnership with the NNSA and the DoD Cost Assessment and Program Evaluation office, Sandia staff and management across the NW SMU collaborated to provide viable options to the Nuclear Weapons Council for a modernized deterrent built on a sustainable nuclear enterprise in a constrained fiscal environment. The effort produced innovative approaches to stockpile modernization while ensuring a healthy infrastructure and Science, Technology, and Engineering base needed to sustain it into the future.

The project to develop qualification alternatives to the retired Sandia Pulsed Reactor established the use of ion pulses created at the Ion Beam Laboratory to replicate neutron damage in transistors composed of GaAs and other III-V semiconductor materials created in MESA. Experiments were also done at the Annular Core Research Reactor and at the White Sands Missile Range fast burst reactor to establish this new capability. (1300, 1100) NW



SANDIA'S ANNULAR CORE Research Reactor.
(Photo by Randy Montoya)



B61-12 Design

The B61-12 program successfully transitioned into Phase 6.3, Full Scale Engineering Development. The team demonstrated leadership in cost management as evidenced through the on-schedule submittal of the B61-12 Weapon Design and Cost Report (WDCR) refined estimate, realizing a significant life-of-program cost reduction relative to earlier estimates. The team also supported a DoD Cost Assessment & Program Evaluation (CAPE) team in its review of the B61-12 cost and schedule. The successful completion of these activities led to Nuclear Weapons Council (NWC) program authorization and a fully funded program in FY13. (2000, 1000, 3000, 4000, 5000, 6000, 8000, 9000, 10000, 200, 400, 500) NW

Sandia completed the Phase 6.2/2A feasibility study for the W88 ALT 370 to develop a replacement Arming, Fuzing and Firing (AF&F) assembly. FY2012 accomplishments included completion of the Conceptual Design Review, Gate Reviews (conceptual design and program plans), and the Weapon Design and Cost Report (WDCR) using a risk-based approach involving scope optimization, critical evaluation of development hardware needs, cost estimate refinement, and significant leveraging of parallel design efforts. Phase 6.3 approval was granted by the Nuclear Weapons Council and Full Scale Engineering Development is proceeding. (200,400,1500,1700, 2100, 2500, 2600, 2900, 5300) NW

In support of weapon Use Control applications, Organizations 2142, 2144, and Honeywell FM&T delivered a new Mark Quality power module to the Department of Defense. The new power module is an upgraded replacement of the module currently used as an integral part of the Code Management System (CMS), a family of products that support multiple user organizations. (2100, 0400) NW

Two teams from Sandia, in partnership with Lawrence Livermore and Los Alamos national laboratories, successfully executed NNSA's 120-day Conceptual Design Study to evaluate interoperable warhead designs for reentry systems. Major design drivers included implementation

in both Mk21 and Mk5 aeroshells, robust safety and security themes, maximum non-nuclear commonality, and cost. Both teams delivered detailed conceptual design reports, multiple full-scale, rapid-prototype weapon models, and extensive briefings to NNSA, the Air Force, the Navy, and the Nuclear Weapons Council. Design architectures and options from the 120-day study are currently informing the W78/88-1 Life Extension Program Phase 6.2. (2100, 8200) NW

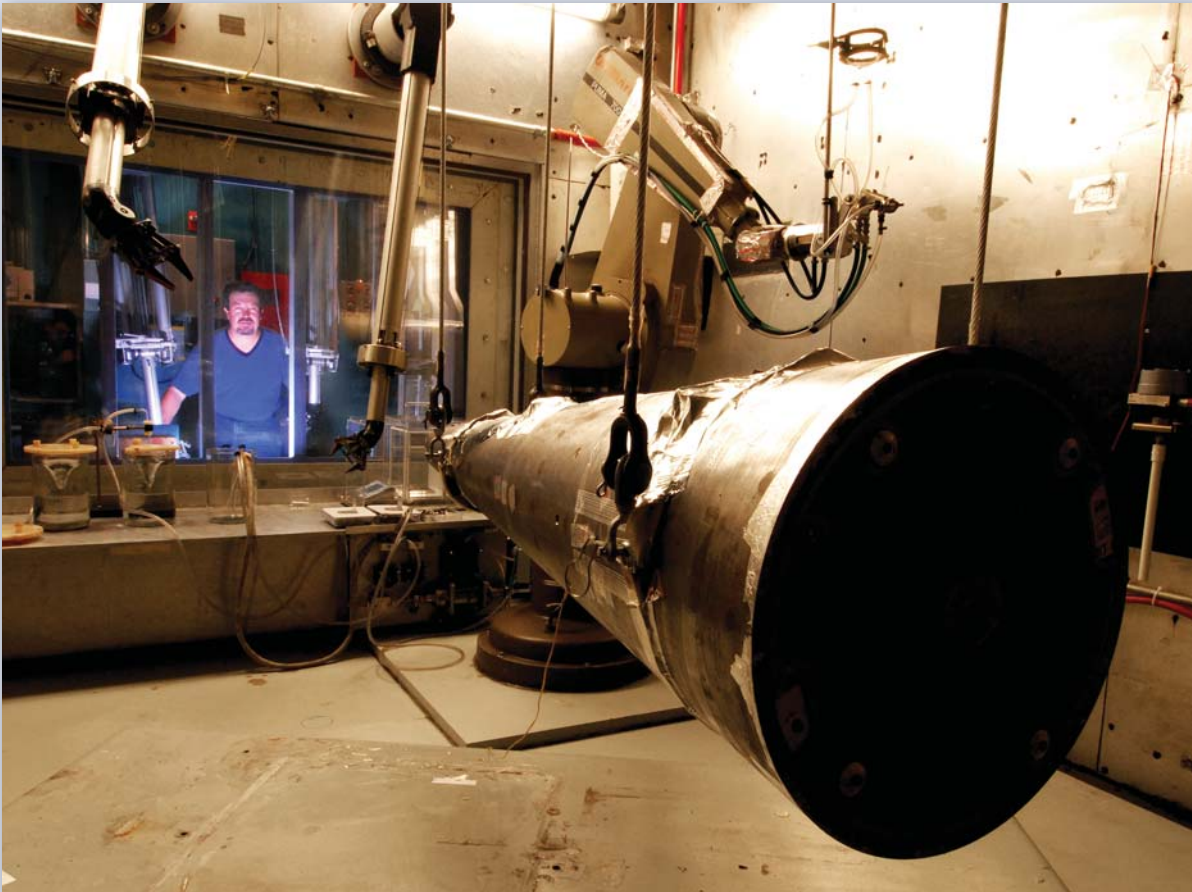
NUWAIX-12, a full-field accident exercise, was conducted May 7-9, 2012. In the exercise scenario, a weather-related accident during a routine B-52 aircraft generation exercise resulted in a Broken Arrow (nuclear weapon accident) and a multi-agency response. Agencies responding included DOE/NNSA nuclear emergency response assets, DoD, the FBI, and other local, state, and federal agencies. Sandia provided numerous responders and controllers for Weapon Recovery and Health and Safety activities at both the ARG home team and the field location. (2900, 200, 400, 1500, 2100, 3600, 4200, 5400, 5900, 6600, 6800, 8200, 10600) NW



ARG AND EXPLOSIVE ORDNANCE DISPOSAL (EOD) set up for field radiography of damaged weapon in a full-field accident exercise.

Sandia's Light Initiated High Explosives (LIHE) facility successfully delivered a tri-planar hostile shock to an arming, fuzing and firing (AF&F) assembly. This required developing a new experimental capability. This new capability required: uniform spray deposition of explosive on three planar surfaces, a new

light array to initiate the three explosive surfaces simultaneously, and a full end-to-end characterization of the data acquisition system. The development team was led by Tim Covert (2556) in partnership with organizations 1522 and 1523. (1500, 2500) NW



SANDIA'S LIGHT INITIATED High Explosives (LIHE) facility. (Photo by Randy Montoya)



BRAD BOSWELL

Immediately after receiving his doctorate in mechanical engineering from the University of Illinois in 2001, Brad Boswell (2127) joined Sandia as a member of the W76-1 System Engineering Team. Brad transitioned to lead the System Qualification team in 2005. While finishing the W76-1 qualification activities in 2008, Brad was named the W88 Weapon System lead engineer. In 2009, he

joined the management team of the Engineering Sciences Center. In late 2010, Brad joined the management team of the B61 Life Extension Program. Brad led a team of program management professionals and project controls experts in the refinement of a previous Weapon Design and Cost Report cost estimate to align with the challenging fiscal constraints facing the nuclear weapon complex. The resulting cost refinement developed further reductions in Sandia design agency costs, allowing the B61-12 program to proceed into Phase 6.3 Full Scale Engineering Development. Throughout the process, Brad has engaged to expand the core team by more than 60 staff this year to meet the growing technical and programmatic challenges of the project. Since submission of the refined estimate, Brad has worked with the team, NNSA, and the Air Force Nuclear Weapons Center to develop strategic approaches to meet the growing expectations for project controls, providing a path to deliver tools for unparalleled understanding and management of complex nuclear weapon projects while providing assurance in execution to executive management, external customers, and oversight organizations.

Nuclear weapons engineering

The W78/88-1 LEP design team completed the Phase 6.1 Conceptual Study and was approved to enter Phase 6.2/2A. The Sandia team, in its system integration role, worked with LLNL to develop multiple conceptual warhead design options for implementation in the Air Force Mk12A reentry vehicle and adaptable to the Navy Mk5. System architectures and layouts were created that integrated seven nuclear explosive packages with complete sets of non-nuclear components. The options were designed and evaluated to meet mass properties, initial military characteristics, and support the Nuclear Safety theme developed by the team. NW



W78LEP Mk12a aeroshell

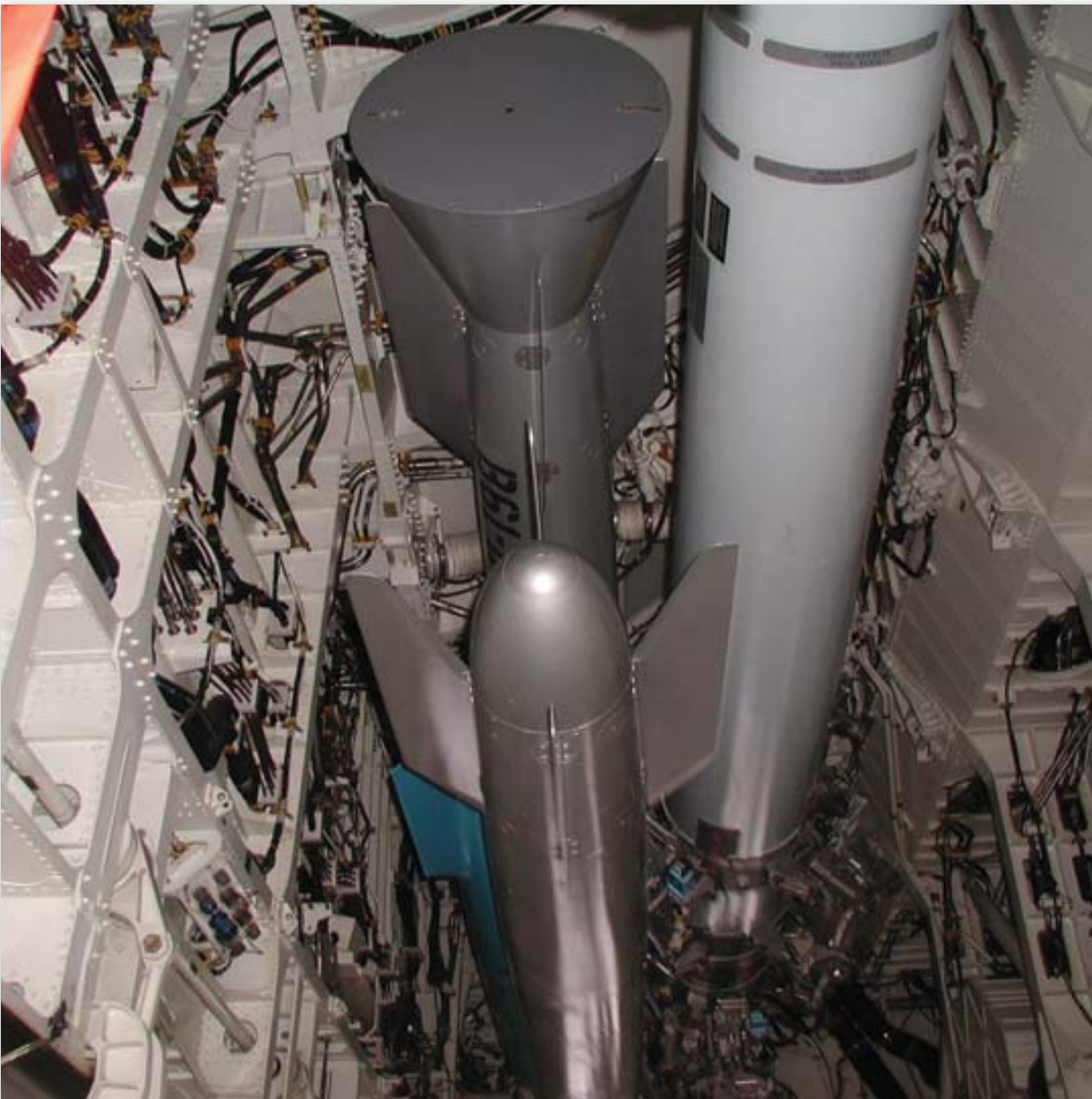
The Explosives Technologies Group (2550), together with the Subsystem and Component Quality Department (0426), qualified and delivered timers and detonators for use in the Small Ferroelectric Neutron Generator. The detonator is a hermetically sealed exploding bridgewire detonator. Both devices were verified through concurrent design and manufacturing to meet all functional, safety, and shelf-life requirements and qualified for production at Excelitas Technologies in Miamisburg, Ohio. (2500) NW

The “Family Tree” activity for NA-10 (NNSA’s Office of Defense Programs) identified the technology development pathways for a number of components in the nuclear weapon program. The results demonstrated both the history and future development pathways for these components to highlight the importance of the technology maturation processes at Sandia. A number of new concepts were highlighted for the NA-10 audience and appreciation for the Sandia process was enhanced at NA-10. (200,1700,2100,2200,2500,2600,2700,5300,8200) NW

The Pentagon-S process is intended to ensure that changes to nuclear safety design requirements are thoroughly evaluated for their effect on released product definition. A team representing the lab stakeholders spent six months developing a new graded rigor identification and change control process. The recommendations for the new Pentagon-S process will be applied during product development phases by Product Realization Teams and used during the weapon lifecycle to control product definition, process definition, testing and acceptance procedures, material handling, special instructions, rework, and specification exceptions. The results of this effort are currently being implemented in the relevant Realized Product Procedures. (400, 2600, 2100, 100) NW

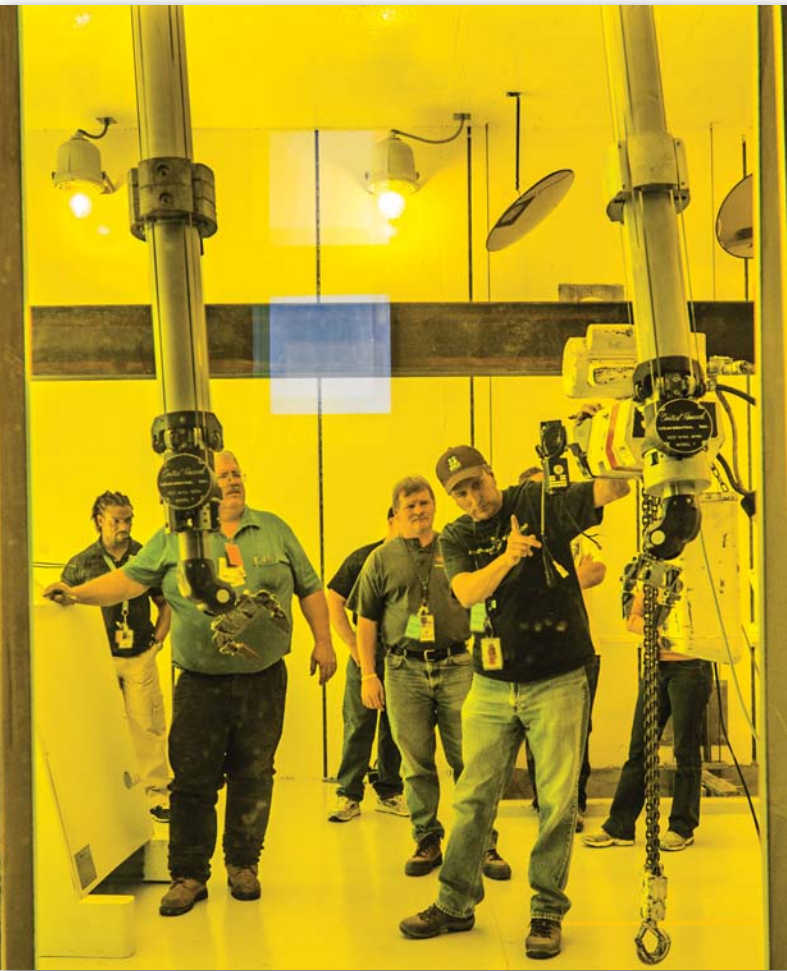
A joint flight test was conducted to increase understanding of B-2A thermal environments. Sandia assembled three test units, a B61-7, B61-11, and B61-12 for thermal environments collection. The USAF instrumented the B-2A port weapons bay and three B61 test units were uploaded. The 24-hour mission was part of

regularly scheduled training for B-2A aircrews originating out of Whiteman AFB. The data collected provides new insight into cold temperature environments in the B-2A serving as a basis for the B61-12 Stockpile-to-Target Sequence cold temperature requirements. (2100, 2900) NW



B61 TEST UNITS mounted in the B-2A aircraft. Data acquired in this flight test provided new insights into cold temperature environments.

Weapon facilities and security



The Tech Area 5 Gamma Irradiation Facility (GIF) successfully achieved approval to downgrade from a Hazard Category 3 nuclear facility to a radiological facility; a first in the history of the NNSA, and is currently transitioning to operate as such. This accomplishment was made possible by determination and diligence of the Non-reactor Nuclear Facilities and Nuclear Materials Management departments to dispose of 272 uncertified 60 Co sources (~20,000 Ci) from the facility. This substantially reduced regulatory compliance requirements and operating costs while maintaining operational and experimental capabilities. 1300 (NW)

Sandia delivered Version 2.1 of the Explosive Ordnance Disposal computer-based training to the Air Force EOD Program for the Nuclear Response Planning/Support Section. This delivery covers the EOD safing procedures for the W80 and the B61 stockpile systems. This training uses CAD animation capabilities that provide EOD personnel with realistic representations of the hazardous parts they may encounter in an accident scenario. A video game-like interface also provides the trainer with a computer-based interface to walk EOD personnel through a hazardous situation they may have to respond to. The previously released Version 1.0 covered EOD procedures for the B83. (2900) NW



Sandia supports NW security for USAFE sites.

In early 2012, the United States Air Forces in Europe (USAFE) accepted Sandia’s nuclear weapon physical security designs for Site 5 and Site 6 in the European theater. Sandia was tasked to design, develop, and implement security upgrades at these two sites. The design upgrade includes a wide-area surveillance system with fixed alarm assessment cameras combined with automatic slew-to-alarm day/night surveillance cameras. (6500) IHNS

INSIDE SANDIA’S GAMMA IRRADIATION FACILITY, recently designated as a radiological facility. Previously it had been a Category 3 nuclear facility.
(Photo by Randy Montoya)

Product realization

The Primary Standards Laboratory (PSL) successfully renewed its ISO/IEC 17025 accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) managed by NIST. Renewal required an in-depth technical evaluation of PSL procedures, technical competency, and quality management system. In FY12, the PSL completed more than 9,379 calibrations, including more than 700 for other Nuclear Security Enterprise sites. The Mechanical Calibration group (2542-2) was recognized at the annual Suppliers Conference by receiving, for the third consecutive year, the Oro Service Award, which recognizes Sandia suppliers and service providers who had a commitment performance greater than 98 percent over the past year. (2500) NW

A SANDIA RESEARCHER examines a polished quartz ball at the Primary Standards Lab. The ball provides a standard for roundness. (Photo by Randy Montoya)



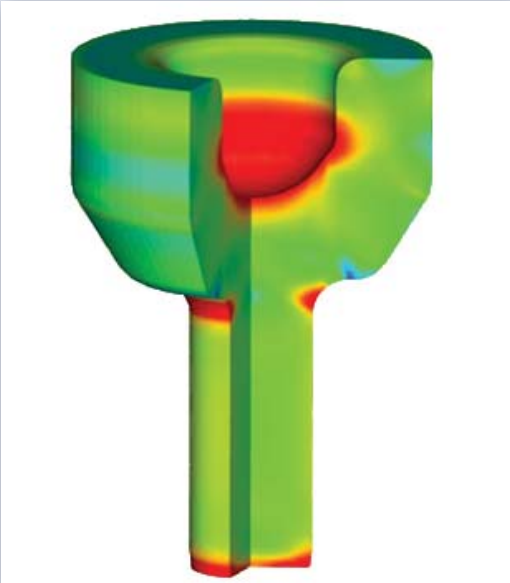
The Neutron Generator Citrus web-based deployment is a valuable knowledge management solution. The NG Enterprise uses many data repositories including shared drives and corporate systems such as EIMS, DDM, and EA Web. Citrus, a Sandia R&D text analysis tool, analyzes various file types to build an index that is used to find relevant documents. Two indices containing more than 1.4 million files were created, and a web-based front end was developed to search the indices and view results. Citrus is approved for unclassified and classified use. (5600, 1400, 2700) NW

After 12 years, Sandia and the Honeywell FM&T Kansas City Plant are preparing to deliver inertial switches. The switch is essential to an Air Force reentry vehicle. Over the past two years, the team overcame numerous technical issues that disrupted previous efforts. After resolving these issues, the team passed a perfect 20 of 20 qualification units through acceptance testing. These units will proceed to further qualification tests before integration into the Mk21/W87. (2600, 8200, 0400, 1800, 1500, KCP) NW

Responsive NG Product Deployment successfully resumed W76/W78 Neutron Generator production following implementation of production process countermeasures designed to prevent the product failure phenomenon. Center resources partnered with SSO, NNSA, and other centers across the Laboratories to engage subject matter experts, technologists, operators, and management using a structured problem-solving methodology to resolve this technical issue. Ultimately, the problem was traced back to an increased sensitivity of an inexpensive commercial product to certain manufacturing processes. This effort resulted in the development of a rework process that allowed recovery of approximately 300 neutron tubes at a substantial cost savings and no impact to directive schedules. (2700, 1500, 1700, 1800, 0420) NW



Neutron Generator



An advanced material model has been demonstrated to accurately predict the strength variability in gas transfer system (GTS) reservoirs due to the forging manufacturing process. The validated model was then used to redesign a forging that was not consistently meeting strength requirements. The new forging is predicted to have improved strength uniformity and decreased sensitivity to processing conditions such as initial ingot temperature and ingot transfer times. (8200) NW

STRENGTH DISTRIBUTIONS in the optimized design.

Using a novel technology that allows coating of active battery materials, the Power Sources Technology Group demonstrated that a thermal battery can be shaped to nearly any geometry. This advancement allows for reserve batteries used in nuclear weapon and other defense applications to be designed to fit available space or be integrated closer to the components that they power. Based on the successes of the technology, Sandia entered into and completed a CRADA with ATB Inc. to transfer and commercialize the technology. (2500) NW



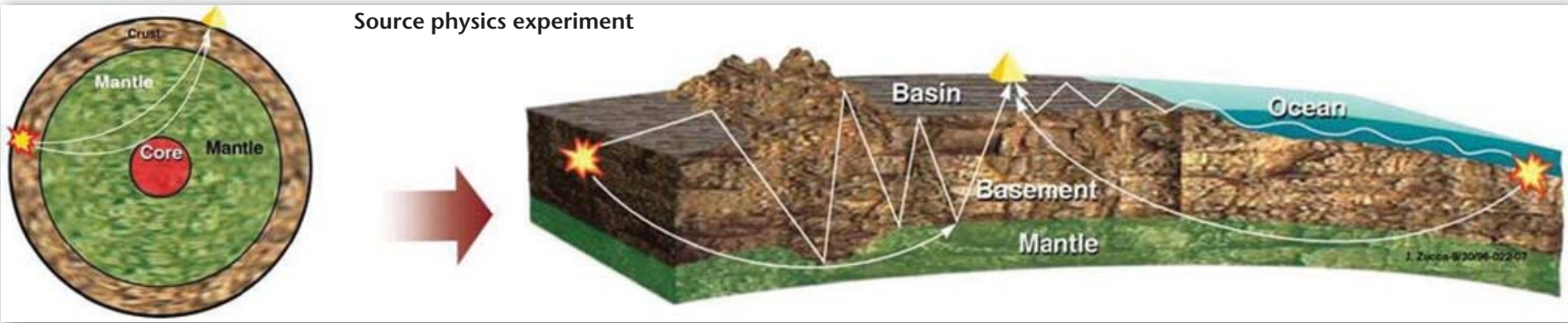
COATED THERMAL BATTERY TECHNOLOGY allows for alternative shapes that fit available space and afford more design flexibility over conventional thermal batteries.



JUAN M. ELIZONDO-DECANINI

Juan M. Elizondo-Decanini (2624) is the recipient of two prestigious R&D 100 Awards, the first in 1997 for the development of an ultra-high-gradient vacuum insulator or “Micro-stack” and the second, in 2012, for the development of the “neutristor,” an ultra-compact neutron generator based on solid-state technology. Juan joined Sandia in 2003 and is currently a distinguished member of the research staff with the Advanced Firing Sub-Systems Department (2624). He received the Individual Technical Excellence Award in 2008, one of Sandia’s highest awards for technical achievement, and in 2011 he was the Sandia featured technical speaker at the NNSA’s Laboratory-Directed Research and Development symposium in Washington. Prior to coming to Sandia, Juan led experimental and theoretical physics groups at several private companies; he has been a member of several design teams at Los Alamos and Lawrence Livermore national laboratories. While at Sandia, Juan has been a member of the design team for the ZR-Z Pinch accelerator, including advanced research work in neutron generators. He is currently developing innovative firing subsystems to support future nuclear weapon life extension programs. He earned his doctorate for work on the physics of laser plasmas under high magnetic fields from the University of New Mexico.

Remote sensing



Precisely at noon Mountain time on July 2 (12:00:00.448), NNSA detonated a chemical explosive equivalent to 2,200 pounds of TNT in a contained, confined environment 150 feet below ground at the Nevada National Security Site. The Source Physics Experiment #3 (see above) was the third in a series of seven underground, fully coupled, high-explosive field tests. The series is a long-term, NNSA R&D campaign designed to improve arms control and non-proliferation treaty verification. (5700, 6900) DSA

To support the US government nuclear test treaty monitoring mission, the US National Data Center system collects and analyzes data from networks of seismic, infrasonic, and hydroacoustic sensors to detect and define explosions within the Earth or at low altitudes. In January 2012, the Air Force Technical Applications Center selected Sandia to design a modern, architecture-centric approach using risk reduction as the primary driver. Sandia's approach will be demonstration-based to provide early investigation and resolution of high-risk technical and performance issues. (5500, 5700) DSA



Sandia-developed Synthetic Aperture Radars are fielded on unmanned aerial vehicles to locate and help defeat improvised explosive devices (IEDs). This program, a partnership between Sandia, NAVAIR, JHU-APL, and ERDC, is currently the most successful JIEDDO-sponsored, airborne IED detection system in Afghanistan. Due to the program's success, the military is requesting additional units and the Deputy Secretary of Defense has directed the capability be transferred to the Army and started the process to potentially transition the capability as a part of a Program of Record. (5300) DSA

Under the sponsorship of NNSA's Defense Nuclear Nonproliferation R&D, Sandia and Los Alamos design, develop and deliver Global Burst Detector payloads for launch on the USAF's Global Positioning System satellites. The current series, GPS IIF, has 12 satellites to be launched over the next six years. On Oct. 4, 2012, the third satellite of the IIF series was launched from Cape Canaveral, Fla. The Sandia/Los Alamos initialization team successfully completed all Early-On-Orbit testing. (5700, 1500, 1700, 1800, 2600, 5300, 5500) DSA

The next-generation Integrated Correlation and Display System, a satellite ground system for processing nuclear detonation detection data, has been delivered to the Air Force. The system utilizes new phased array antenna, spread spectrum receivers, multi-node network

computing, and 1.5 million lines of custom software to fuse data from sensor payloads on more than 30 different satellites to national authorities. The delivery culminates a six-year effort by a team of more than 100 people. During the development the team also achieved AS9100C Quality certification. (5700, 5500, 5300, 2600) DSA

A team of nanomaterials researchers at Sandia has developed a new technique for radiation detection that could make radiation detection in cargo and baggage more effective and less costly for homeland security personnel. Spectral Shape Discrimination takes advantage of a new class of nanoporous materials known as metal-organic frameworks, ideal because they have tailorable nanoporosity and ultrahigh surface areas. An exciting video has been created outlining the latest research. (5700, 8100, 8600) DSA

Robotics and engineered safety

Sandia has developed a low-cost robotic hand, capable of performing very complex manipulation tasks, that can be used to support a wide variety of missions including Counter IED, Counter mine, and Search and Rescue. Current robotic hands cost \$250,000 or more, yet Sandia was able to design and build a robotic hand with increased dexterity for about \$10,000. The Sandia Hand is being provided as Government Furnished Equipment for the DARPA Robotics Challenge Program, which is intended to develop robotic systems to address national emergencies, such as a Fukushima-like disaster. (6500) IHNS

Staff members of 8223 and 8226 are busy putting the finishing touches on their new Picasso robotic spray painting system. More than a year in the making, and serving as an Engineered Safety test case, Picasso features an ABB Inc. industrial robot capable of spraying uniform coatings on complex shapes. While primarily intended for applying coatings containing nanomaterials, Picasso has a wide range of application capabilities and will serve as a useful tool in the coming years. (8200) NW



LOW-COST Sandia robotic hand. (Photo by Randy Montoya)

A NAVAIR Tigershark unmanned aerial vehicle (UAV) equipped with a Sandia-developed synthetic aperture radar (SAR).



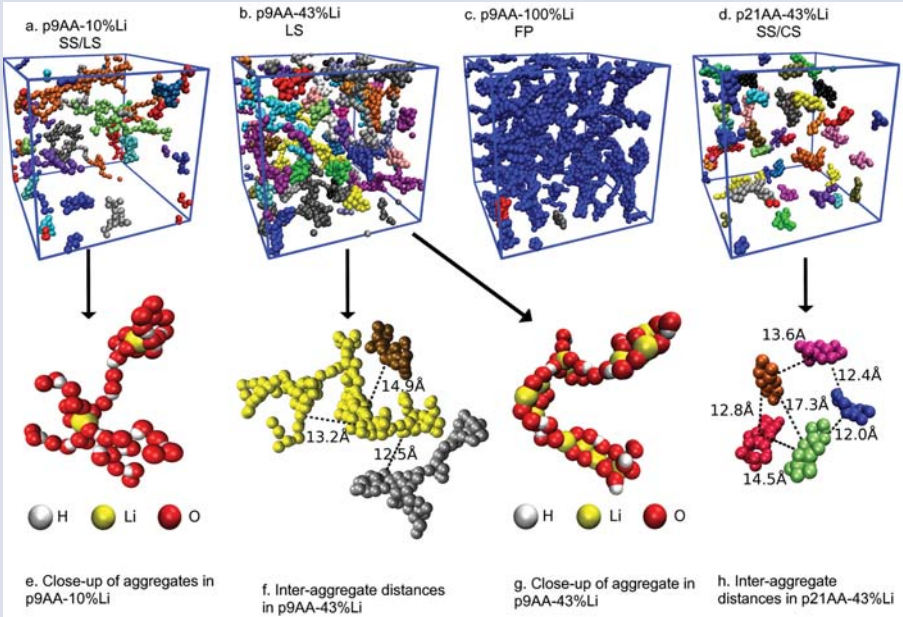
Materials

The InGaN material system forms the basis for visible light emitting diodes (LEDs) that enable energy-efficient solid-state lighting. We developed a diagnostic tool for quantitative measurement of defect density in the light-emitting layers of InGaN LEDs. Clustering of defects within these regions was found, which could help explain and improve energy efficiency in LEDs. Understanding and controlling such defect distributions in InGaN LEDs may enable the next generation of energy-efficient LED-based lighting for our homes and offices. (1100) ECIS

Sandia researchers have developed new ceramic capacitor materials with high permittivity under large electric fields, resulting in energy storage densities 2-3 times greater than comparable commercial capacitors. These new materials have been scaled up to multilayer capacitor prototypes. This breakthrough enables smaller packages for firing sets and other applications. In addition, our ceramic capacitors exhibit stable and reliable performance at temperatures as high as 400°C, making them excellent candidates for integration with SiC-based power electronics modules for photovoltaic inverters and other high-temperature electronics packages. (1800) NW, ERN

Center 1100 researchers led by Taisuke Ohta collaborating with the Naval Research Lab have observed and advanced the understanding of direct, tunable coupling between adjacent atomically thin graphene layers with azimuthal misorientations (twists). Their direct measurement of layer orientation via low energy electron microscopy, together with Raman and optical spectroscopy, demonstrate that interlayer coupling can be reversibly turned off through chemical modification. These results provide a scientific basis for novel bilayer graphene device concepts, relying on interlayer hybridization to harness “designer” electronic or optical properties. (1100) ECIS, DSA

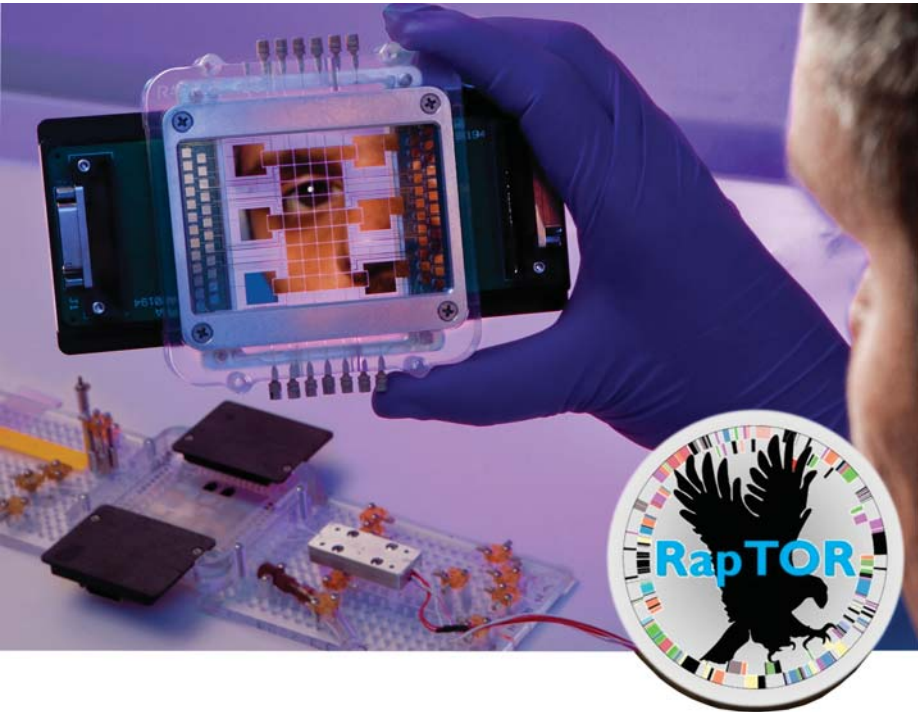
Ion conducting polymers (ionomers) have many potential advantages as solid electrolytes for batteries, but demonstrate inadequate conductivity. Understanding the structure of ionic clusters in ionomers is critical to improving ionic conduction. Simulation has determined a variety of cluster morphologies that match experimental X-ray data but were previously unsuspected. Furthermore, the mechanism of ion transport has been found to involve cluster collisions and exchange of ions between clusters. These revelations imply new strategies for designing ionomers with better conductivity. (1800, 1500, 8600) LDRD



Panels (a)-(d): Snapshots showing variation of morphology for variation in Li content and spacer length (9 and 21), where coloring is by aggregate. p9AA-10% Li refers to an acrylic acid monomer of precisely 9 carbon atoms long between carboxylate groups with 10% of these group neutralized with lithium. Panels (e) and (g): Close-up images of aggregates in p9AA-10%Li and p9AA-43%Li, respectively, showing lithium, oxygen, and carboxyl hydrogen atoms. Panels (f) and (h): Typical inter-aggregate distances in p9AA-43%Li and p21AA-43%Li, respectively, which correspond to peak in X-ray scattering.

Bioscience

Dramatic advances in biotechnology make technical surprise due to genetically engineered bioweapons a growing threat to national security. The Rapid Threat Organism Recognition (RapTOR) Grand Challenge has developed and integrated technical innovations in molecular biology, microfluidics, and bioinformatics to create a new capability, based on second-generation sequencing, to obtain maximum genetic information from an unknown pathogen rapidly enough for decision makers to effectively respond to an attack or outbreak. This work has broad applications and attracted interest from diverse sponsors. IHNS

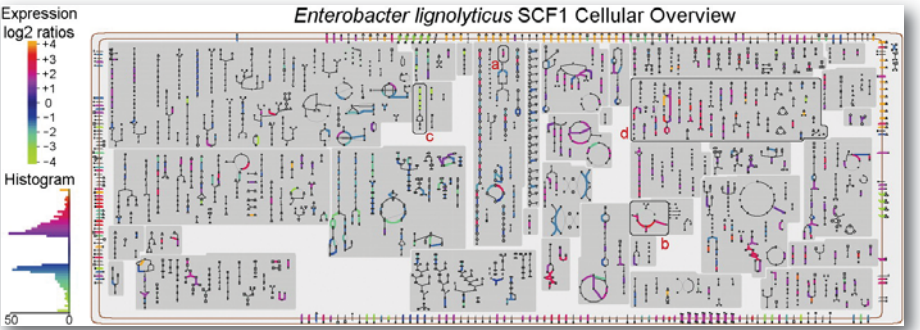


RapTOR — Sandia’s Digital Microfluidic Hub droplet router enables the interconnection of diverse processing and analysis modules to automate complex microliter-scale molecular biology sample-preparation protocols for next-generation sequencing.

Sandians working at the Joint BioEnergy Institute (JBEI) identified a tropical rainforest microbe that can endure relatively high concentrations of an ionic liquid used to dissolve cellulosic biomass. They also determined how the microbe is able to do this, a discovery that holds broad implications beyond the production of advanced biofuels. The study demonstrates that vigorous efforts to discover and analyze the unique properties of microorganisms can provide an important basis for understanding microbial stress and adaptation responses to anthropogenic chemicals used in industry. (8600) ECIS



Joint BioEnergy Institute (JBEI)
(Photo by Dino Vournas)



WHOLE-GENOME METABOLIC RECONSTRUCTION of SCF1 showing differentially expressed pathways and transporters. Reactions in the network corresponding to significantly over- or underexpressed genes in 375 mM [C2mim]Cl vs. 375 mM NaCl were colored based on their log ratio, ranging from orange for log ratio >4.0 (16-fold or more up-regulated in [C2mim]Cl) to light green for log ratio <-4.0 (16-fold or more up-regulated in NaCl). Transporters are arranged around the boundary. Selected enzymatic reactions or pathways include cyclopropane synthesis (a), fatty acid-oxidation (b), enterobactin biosynthesis (c), and amino acid degradation and conversion (d).



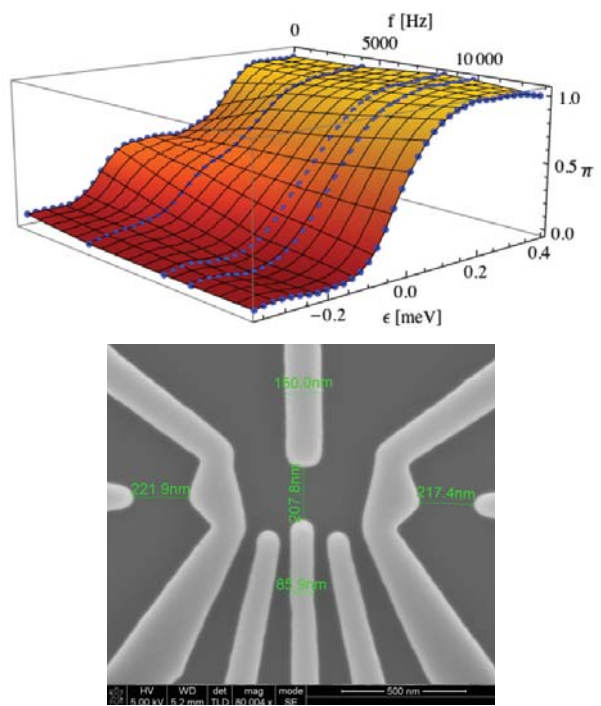
SUSAN REMPE

Susan Rempe (8635) led a team of Sandia and University of New Mexico scientists whose research on biomimetic membranes resulted in a breakthrough in membrane design for efficient water purification. The synthetic membranes were designed to mimic key structural features found in cell membranes that deionize water with far higher efficiency than commercial membranes used in reverse osmosis (RO) technology. Advances in theoretical modeling developed in Susan’s lab in collaboration with David Rogers (8635) were essential for deciphering how biological pore structures selectively remove ions, thereby guiding pore design for efficient new membranes. Novel synthetic strategies developed in the laboratories of Sandia Fellow Jeff Brinker (1002)

and Ying-Bing Jiang (UNM) were instrumental in fabricating highly ordered nanoporous membranes with tailor-made pore geometries and interior surfaces. In initial tests, the biomimetic membranes achieved a 10-fold improvement in water purification efficiency compared with state-of-the-art commercial RO membranes. *R&D Magazine* recognized this achievement with an R&D 100 award. In recognition of her work, Susan was also honored by the University of Washington Chemistry Department in an awards ceremony last April. The University of Melbourne in Australia recognized Susan’s achievements with the Wilsmore Fellowship, which funded her scholarship in residence. Sandia’s LDRD program funded the research on biomimetic membranes.

Computer & information sciences

The AQUARIUS Grand Challenge LDRD team has invented and executed world-first benchmark tests for quantum behavior on its silicon-based one-qubit adiabatic quantum computer. The tests indicate that the device’s observed operation is more attributable to decoherence assistance than “adiabatic” quantum effects. As a byproduct, the test measures important energy-dependent relaxation times for silicon qubits. Future devices from our atomic-precision lithography fab seek to demonstrate pure adiabatic quantum behavior. That decoherence assists, rather than corrupts, emboldens theoretical predictions of the adiabatic architecture’s robustness to noise. (1100, 1700, 5600, 8900, 9300) CTO, DSA, IHNS, NW



(a) The Sandia silicon qubit. Potentials applied to the light-colored polysilicon lines create a “double quantum dot,” which is a double well that confines a single electron (the qubit) to the right or left half of the central dark region. (b) The mean occupation of the left well as a function of relative well potential has triple-plateau behavior when the potential is driven at low frequency but double-plateau behavior when it is driven at high frequency. The transition between these regimes provides information about the qubit’s energy-dependent relaxation time.

Cyber researchers developed a new suite of tools to enhance cybersecurity analysts’ ability to identify suspicious visitor patterns to websites — identifying possible reconnaissance in preparation for a social engineering attack. Tools include the following capabilities: a website visualization technique allowing visits to be easily compared to heuristic patterns; an automated analysis separating human-driven browser traffic from automated crawler traffic based on their visit patterns. This work could have a profound impact on the analyst’s job — changing from reactive response to proactive defense. (5600, 9300) DSA

In June 2012, to foster collaboration with industry, academia, and government, Sandia opened the doors of the Cybersecurity Technologies Research Laboratory (CTRL), the California facility for the joint New Mexico/California Cyber Engineering Research Institute. CTRL provides an open, yet secure, facility for research and partnering to address the toughest challenges in cybersecurity. CTRL’s location on the Livermore Valley Open Campus makes it an ideal gathering place for cybersecurity experts. CTRL offers partners a gateway to Sandia’s capabilities in engineering solutions to high-complexity, high-consequence security issues. (8900, 8500) ECIS, DSA, NW



RESEARCHERS DISCUSS A THORNY CHALLENGE at Sandia’s new Cybersecurity Technologies Research Laboratory on the Livermore Valley Open Campus.

Megadroid is a collection of tools for emulating large-scale Android cell phone environments. Megadroid can emulate hundreds of thousands of devices concurrently. Additionally, Megadroid provides simulated GPS data and GSM support. (8900) (All)

DAVID FRITZ stands in front of the KANE cluster, used to run Megadroid. (Photo by Dino Vournas)



Sandia released the CoopR software library, which provides a rich environment for formulating and analyzing optimization models. CoopR is used at Sandia and externally to solve complex real-world problems, including hydraulic reservoir management, energy economic modeling, forestry planning, electric power generation expansion, nuclear weapons enterprise planning, and design of contamination warning systems. CoopR is distributed freely, and it has many users (approximately 4,000 downloads during FY12). Additionally, CoopR is being used in undergraduate and graduate classrooms: UC Davis, USC, Univesity of Texas, George Washington University, and Rose Hulman. (1400) DSA, ECIS, NW



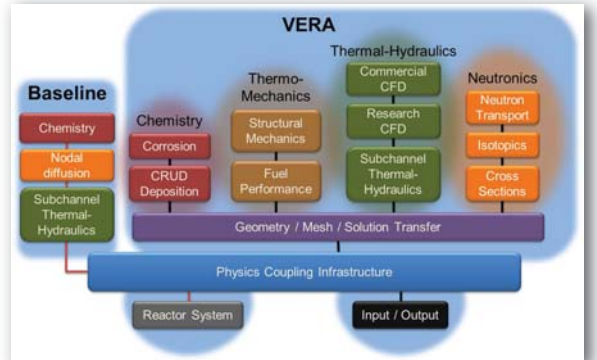
The Cyber Operations Research and Network Analysis project, (CORONA), was selected as the best cyber modeling/simulation project at the 7th Annual Intelligence Community Tech Expo. It was also recognized as one of the intelligence community’s Top 12 technology efforts. CORONA provides a scalable framework environment by constructing a diverse foundation of Live Virtual Constructive elements. CORONA is a joint project with DIA/Missile & Space Intelligence Center, and US Air Force’s 688th Information Operations Wing, with funding through the DoD Modeling and Simulation Coordination Office. DSA



VINCE URIAS

How do you grow talent for the future? You start with an energetic high school intern, expose him to a dynamic operational environment with lots of problems that need to be solved, keep him interning throughout his entire college experience (both BS and MS), and then hire him. This is how it worked with Vince Urias (9516). He was hired as an intern in 2001. Vince has been a regular employee now for just over three years. His internship experiences gave him an appreciation for the complexity involved in computing environments, an idea of how operations management affects productivity, and ultimately started the creative process and research quest for him. Since being hired as a full-time employee, Vince has been working in the areas of cloud computing and software defined networking. This year his work on Computer Network Deception was funded as an LDRD project. When not working on his LDRD, he’s been co-leading innovation in cyber testing and evaluation. This research is creating the foundations for large-scale modeling and simulation platforms with leading-edge scale, fidelity, and boot-up times. His work has been published in respected journals and conferences, including MILCOM, ACM’s CCS, Carnahan, ICSQ, and the DOE Information Management Conference. This breakthrough has generated interest from many organizations, including DoD and DHS.

Sandia contributed key computational technologies, including advanced simulation codes, multiphysics coupling methods, solver libraries, and tools for verification and uncertainty quantification, to the Consortium for Advanced Simulation of Light Water Reactors (CASL). These capabilities comprise the foundation of the Virtual Environment for Reactor Applications (VERA) recently released by CASL for use by its nuclear industry partners. Sandia led efforts to develop and integrate these capabilities with other codes in VERA, which is addressing many of the most challenging operational and safety problems in nuclear plants. (1400) ECIS



VERA: A suite of tools for scalable simulation of nuclear reactor core behavior

IT, networks, & facilities

The Facilities Management and Operations Center developed a Five-Year Facilities and Infrastructure Plan to articulate a comprehensive, multiprogram approach to capital investment, sustainability, and space-management efforts to meet Sandia strategic objectives and NNSA goals. The plan sets targets to improve mission productivity through strategic colocation within asset management targets and it details strategies for each site. Approval of the plan resulted in investment funding of \$10 million–\$16 million/year to construct three buildings in the near term and address longer-term demolition and renovation strategies. (1000, 2000, 4800, 5000, 6000, 8000) All SMUs



MECHANICAL OPERATIONS ENGINEER Casiano Armenta (4824) checks out a heat exchanger in Bldg. 726 that's part of Sandia's free-cooling system. Free cooling is the use of cold, dry outside air in late fall, winter, and early spring to chill water for air conditioning in data centers that need year-round refrigeration. Water runs from a cooling tower through the heat exchanger and straight into buildings, bypassing energy-consuming chillers. Free cooling has helped Sandia cut energy usage by more than 250 billion BTUs the past six years and reduce greenhouse gas emissions. (Photo by Randy Montoya)



LAURA LENBERG

Sandia computing infrastructure has quietly and seamlessly transformed how infrastructure servers deliver large-scale applications to the Sandia community. **Laura Lenberg**, (9329) and her team have deployed more than 700 virtual servers spanning six network partitions and multiple Sandia sites. Typical physical servers achieve 10 to 15 percent utilization of total capacity, yet require 100 percent power and cooling.

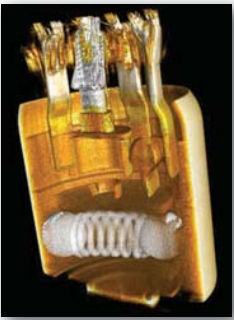
Organizations typically run only one application per server. Laura has designed and implemented server virtualization on an increasing scale, which has enabled the retirement and non-replacement of obsolete servers, freeing up floor space, power, and cooling capacity for more virtualization capacity in the future. Laura's deployment has an estimated cost savings in hardware of \$4.2 million. Subtracting the cost of the specialty servers (\$13,000 each, including software licenses) and system partitioning costs, the accumulated host savings are estimated at \$3.386 million. Direct and indirect (accounting for the cooling of servers) electricity net savings are estimated at 2,235,550 kWh/year, which is equal to slightly more than \$200,000 per year. Because of Laura's work, the Labs will not need to upgrade 700 or more blade or rack-mount servers. Thus, server virtualization is an excellent example of cradle-to-cradle environmental stewardship.

Supply chain

NNSA's independent review team (PERT) recognized Sandia's Procurement organization for its strong leadership, excellence in contract administration, and training. The successful PERT review allows Procurement to maintain its independent signature authority of \$20 million. This signature authority is significant in supporting streamlined contract placement. The team, made up of procurement experts from NNSA and NNSA sites, specifically recognized auditing, contract closeout and training for demonstrating best practices in the complex. (10200) All SMUs

In 2012, Sandia successfully completed its last five major Facilities and Infrastructure Recapitalization Program projects on time and within budget. Total expenditures during the program were \$180 million (including two line item projects totaling \$83 million), with \$28 million in Disposition and Dismantlement. In addition to revitalizing critical facilities and enabling infrastructure at both the New Mexico and California campuses, this highly successful, decade-long, sustained NNSA effort eliminated or retired a combined \$11,850,000 in deferred maintenance costs in 2012 alone. (4800) NW

An innovative irregular approach to computed tomography reconstruction using graphics processors for industrial applications was developed and submitted for a technical advance. The resulting algorithm permits the reconstruction of up to trillions of volumetric pixels from thousands of high-resolution X-ray images. It has the added benefit of being highly portable, allowing a user to use this software on many systems, ranging from a laptop to a supercomputer. The algorithm permits the reconstruction of volumetric information up to 1,000 times faster than traditional approaches. (9500) NW



THIS COMPUTER-RENDERED 3-D image of a rotary switch used an innovative new algorithm to complete the Computed Tomography reconstruction in about 2 minutes.

Sandia installed several new high-performance computing systems, four of which were ranked in the top 100 fastest systems in the world. The new capacity clusters (Chama, Pecos, Dark Bridge, and Dark Sand) were purchased as part of NNSA's Advanced Scientific Computing program and Sandia's newly formed Institutional Computing program. The Institutional Computing program provides resources that support work in all SMUs and prepares Sandia to explore rapidly growing areas of interest in such fields as informatics, emulitics, and cloud computing. (9300) All SMUs

Partnerships & alliances

On Sept. 12, Sandia hosted the first annual Sandia Research & Technology Showcase at an Albuquerque hotel. The day-long event showcased cutting-edge research and technology development taking place at Sandia and its application to national security. The event bolstered Sandia's Industry Partnerships outreach efforts by highlighting success stories and providing information on how to do business with Sandia through licensing, partnerships, procurement, and economic development programs. The event transformed Sandia's outreach efforts and drew more than 380 attendees including industry representatives from 11 states. (1900) All SMUs

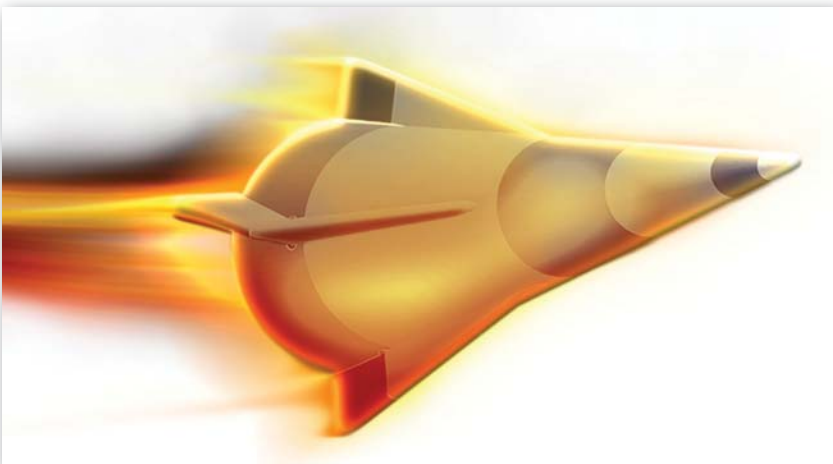


PANELISTS at the Sandia's Research and Technology Showcase shared success stories about partnering with Sandia. (Photo by Randy Montoya)

Sandia substantially grew the Military Summer Intern Program in FY12, hosting at both the California and Albuquerque sites cadets and midshipmen from the US Merchant Marine Academy, the Coast Guard Academy, the Air Force Academy, and the Naval Academy. Interns spent about 4-5 weeks working in R&D organizations, performing hands-on work, and contributing to a variety of Sandia's National Security Missions. This program was enthusiastically supported by the academies, Sandia technical staff, and leadership at NNSA. (200) NW

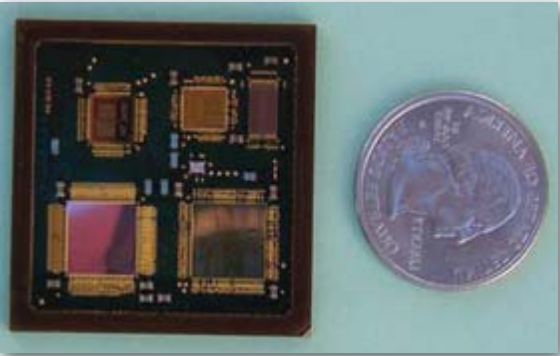
Military programs

AHW Flight 1A: On Nov. 17, 2011, Sandia’s Integrated Military Systems Program conducted the first test flight of the Advanced Hypersonic Weapon (AHW), which was launched from Sandia’s Kauai Test Facility. A Sandia-designed booster system launched the Sandia AHW glide vehicle and successfully deployed it on the desired flight trajectory. The test demonstrated the viability of the boost-glide approach to long-range atmospheric flight and data collection on a variety of advanced technology subsystems. Highly successful, the AHW was selected as a Lockheed Martin NOVA award winner. DSA



AHW HGB-1 with trail.

The Sandia-designed Key Data Processor (KDP) cryptographic engine mandated by the Joint Chiefs of Staff for use in all military Global Positioning System (GPS) receivers reached the 1,000,000-unit milestone in May 2012. Sandia worked with internal and external organizations to develop the next-generation system-on-chip, National Security Agency-certified architecture enabling receiver manufacturers to securely integrate the KDP-III/IV into their custom application specific integrated circuits (ASICs) realizing cost, size, and power reductions necessary for insertion into constrained applications including precision guided munitions and artillery shells. (2600, 1700, 5600, 0400) DSA



KDP-II MULTICHIP MODULE.

The Military Operations Research Society (MORS) has awarded the Integrated Military Systems’ Capability Portfolio Analysis Tool (CPAT) team with the national 2012 Richard H. Barchi Prize for the paper titled “Program Executive Office Ground Combat Systems (PEO GCS) Modernization Analysis Tool.” The submission was selected for its substantive nature, appropriateness to operations research/systems analysis, originality, and contribution to the community of interest. The paper outlines CPAT’s ability to execute a comprehensive assessment of PEO GCS modernization initiatives and develop a multi-agency analytical team to tackle this arduous task. DSA



STEVE CASTILLO

his outstanding technical and professional achievements.

Steve Castillo, manager of Sandia’s Intelligence, Surveillance and Reconnaissance Systems Engineering & Decision Support group, received the Engineer of the Year award at the Hispanic Engineering National Achievement Awards Conference (HENAAC), the highest accolade by HENAAC, which recognizes leadership and technical or scientific achievements. “We are very pleased that Steve is being recognized for

The Kauai Test Facility (KTF) celebrated 50 years of service in June 2012. KTF was established in 1962 to support the Atomic Energy Commission, providing key development, test, and evaluation capabilities that to this day continue in support of a broader national security mission. KTF has delivered mission success on hundreds of launches while maintaining an outstanding record of safety, security, and reliability. The programs and work performed at KTF have provided Sandia with the opportunity to support the complete technical project lifecycle. KTF is a critical asset to Sandia as the mission continues to diversify in direct support of emerging national security objectives. DSA



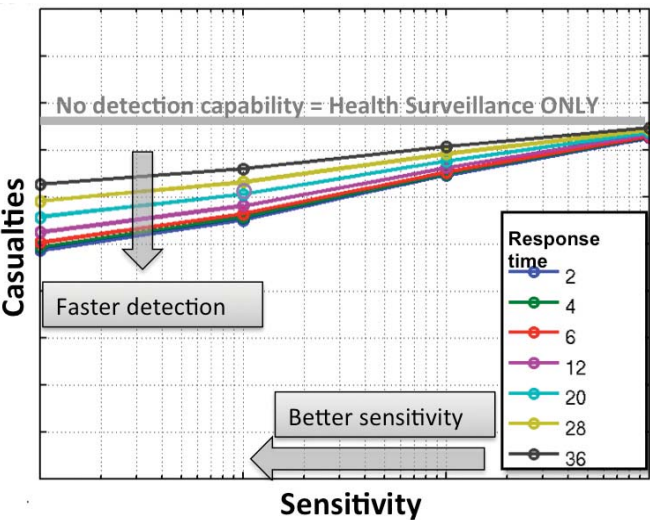
A RAINBOW BREAKS over the Launch Operations Building at Sandia’s Kauai Test Facility.

Homeland security

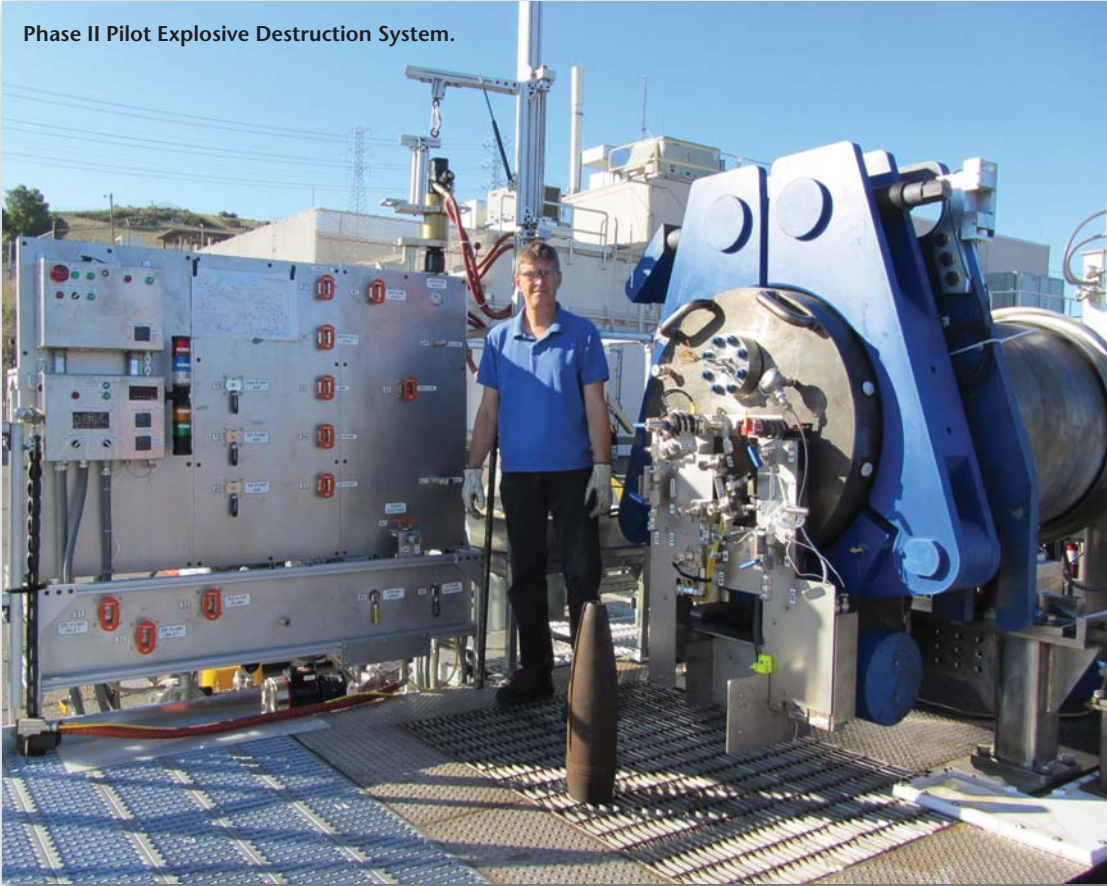
Sandia completed fabrication and chemical agent testing of the Phase II Pilot Explosive Destruction System (EDS). Major improvements, including use of Sandia-developed sensor technologies, have cut the operating cycle in half, improved worker safety, and accommodated more munitions. The improvements were demonstrated in mustard

agent tests at Aberdeen Proving Ground. The EDS is the nation’s primary tool for destroying recovered chemical munitions. These improvements provide significantly greater capacity needed to remediate chemical munition burial sites that exist in most states. (1700, 5400, 5900, 8100) IHNS.

Nerayo Teclemariam and Garrett Barter, along with Peter Davies, Duane Lindner, Nate Gleason, and Todd West (all 8100), briefed senior leadership of the DHS Science & Technology Directorate and Office of Health Affairs on an analysis of a new candidate biodetection system for the BioWatch program. The analysis focused on understanding various performance metrics, as well as quantifying the tradeoffs between detection sensitivity and response time. Results of the analysis are being used by DHS for a potential \$5 billion (lifecycle cost) acquisition. (8100) (IHNS)



TECHNICAL ANALYSIS conducted in support of DHS biodetection.



Microelectronics & microsystems



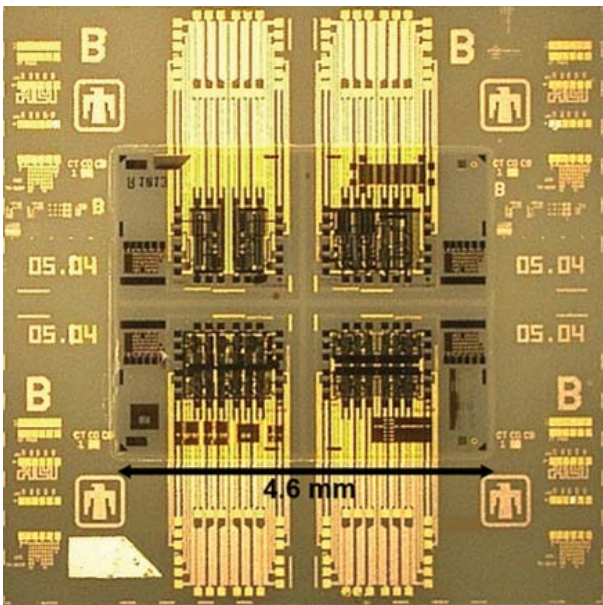
SUBHASH SHINDE

Subhash Shinde, manager of Concentrating Solar Technologies Dept. 6123, has been named a 2013 IEEE Fellow. This is the highest IEEE membership grade and is recognized by the technical community as a prestigious honor and an important career achievement. Subhash initiated Sandia projects on 3-D integration of microsystems. His work led to one LDRD and two Grand Challenge projects that have helped create

the 3-D integration capability in the MESA facility. IEEE recognized these contributions in awarding Subhash IEEE Fellow status.

Subhash joined Sandia in 2004 after 18 years with IBM. He was a principal research staff member in Fab Operations Dept. 1746, working in the area of 3-D integration of microsystems. In Fab Operations Dept. 1646, his team worked on developing advanced architectures only possible through 3-D integration. The team has published its work at IEEE's Electronic Components and Technology Conferences (ECTC), Materials Research Society conferences, and at DARPA workshops. Additionally, Subhash has organized five 3-D Integration ECTC sessions.

Subhash received his doctorate in materials science and engineering at Stanford University and has more than 35 publications, 60 US patents, and 10 international patents. He is the editor of two books published by Springer-Verlag, with a third to be published in 2013. Subhash serves as a judge in state science fairs as a way of encouraging young people to consider careers in science, technology, engineering, and math.



OPTICAL MICROGRAPH of heterointegrated test assembly.

Sandia demonstrated single-chip heterogeneous integration using flip-chip die attach and substrate removal to integrate GaAs-based integrated circuits onto non-native substrates. The integrated circuits showed electrical properties equivalent to lattice-matched circuits, >10 percent reduction in interconnect capacitance, and >100X reduction in test circuit crosstalk. This important advance provides an integration environment that enables smaller, lower power, higher reliability mixed-technology integrated circuits and microsystems in which CMOS technologies perform data processing and memory, and compound semiconductors provide optoelectronic, radio frequency, and driver capability. (1700, 1300) DS&A, NW

Three structured ASICs have been developed in Center 1700 to support diverse integrated circuit applications in the upcoming NW LEPs. These are the Eiger digital structured ASIC, Whistler analog/mixed-signal structured ASIC, and the Shasta radiation-hard optimized structured ASIC. These structured ASIC platforms provide a versatile collection of digital and analog processing and computing resources that can be applied to high-reliability applications and provide the additional advantages of lower costs and quicker time to implementation as compared to traditional custom ASICs. (1700) NW

HR & finance

The Military Support Committee's vision is to engage all levels of the workforce to foster a military-friendly community and culture that supports Sandia's mission. The committee's significant recognitions included the Pro Patria Award, a state-level award given by the Employer Support of

the Guard and Reserve; and a national nomination for the Department of Defense Freedom Award. Also, the Wounded Warrior Career Program, designed to help severely injured veterans and key family members transition to civilian careers, expanded and met its program goals. (3010)



MILITARY SUPPORT — Michael Hazen, VP of Infrastructure Operations Div. 4000 (far right), accepted awards on Sandia's behalf from Gov. Susana Martinez (next to Michael) during a luncheon April 19 honoring employers that support their National Guard and Reserve members. Joining Michael in accepting the Pro Patria award, the state's highest honor for supporting Guard and Reserve employees, are, left to right, Machel Karler (3512), Rose Gehrke (10617), Jody Thomas (2733), Gilbert Morales (10685), Esther Hernandez (40), and Raymond Battaglini, state chairman of the New Mexico Employer Support for the Guard and Reserve. (Photo by Randy Montoya)

Sandia's recruiting program added numerous tools, including a customized app, a Twitter account, a quick-response code, and internal initiatives such as an easy-to-use website, learning portal, talent management mentoring program, and a market-based performance compensation system. These tools helped Recruiting meet an increased workload without increasing staff. In 2012, Sandia hired 883 regular employees, more than 1,000 students, 408 summer students, 165 year-round students and 11 co-ops. (3500, 3600, 3300)

The Media Relations and Communications team received the Grand Award — the highest national honor — in the annual Apex Awards competition for the Lab News' 9/11 issue, plus eight more awards. The staff garnered widespread recognition of Sandia's techni-

cal work through 93 news releases and nearly 600 media interactions, nearly equal to the total for the previous two years combined. And the Media Relations social media platforms passed more than 10,000 followers on Twitter, 2,700 "likes" on Facebook, 25,000 views on Flickr, and nearly 2 million YouTube views. (3651) HR

The CFO & Business Operations and Human Resources organizations teamed to define the resource management process that integrates the SMU projections of revenue and costs with division workforce planning. The process produced division workforce plans that align with SMU projections and support the Labs' mission. The new process provides executive management with confidence when approving the workforce plans and the resulting Labs hiring plan. (10000, 3000) All SMUs

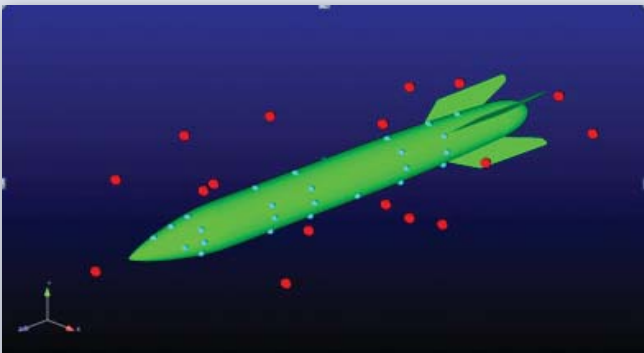
Health Benefits Employee Services evolved Sandia TotalHealth by adding a HealthPartner Network with lower member costs. The program expanded to include spouses who can earn \$250 for completing an online health assessment and an additional \$250 toward deductibles and copays by engaging in healthy behaviors. Participation in the healthy behaviors incentive program has reached 77 percent of employees and almost 50 percent of spouses. Despite a 3 percent increase in enrollment, Sandia's healthcare costs grew 2 percent slower than the national trend. (3300) IMS



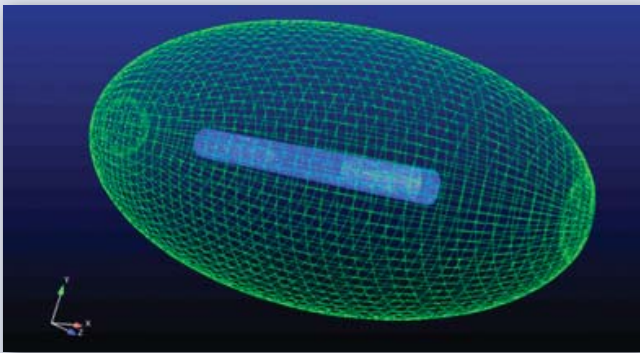
SANDIA'S HEALTHCARE STRATEGY FRAMEWORK has a strong wellness component. (Photo by Randy Montoya)

Engineering sciences

A new forward/inverse structural-acoustics computational simulation capability was developed this year. This important capability is able to simulate under wing captive carry vibration conditions for the B61 and the vibrational environments for RVs. The ability to perform inverse simulations in which the desired experimental acoustic conditions can be computed to create complex spatially varying environments is a unique and powerful new tool. Because inverse problems take experimental data as input, this new computational capability is a further integration of computational and experimental simulation capabilities. (1500) NW



CONTROL POINTS for acoustics inverse problem.



STRUCTURAL MODEL surrounded by a infinite element acoustic mesh.

New constitutive models have been developed and validated to improve our ability to model complex materials of importance in NW and DSA needs, especially in the area of encapsulation and joints. A coupled chemical-thermal-mechanical constitutive model has been developed for polymer reaction, solidification, and curing. In addition, new unified creep plasticity constitutive models have been developed for foams, solders, and braze alloys. These models allow us to make improved physics-based assessments of mechanical behavior to support design, qualification, and testing of components. (1500, 1800, 8200) NW, DSA

A million-gallon groundwater pumping test was conducted in the Culebra Dolomite south of the Waste Isolation Pilot Plant (WIPP). The test pumped the 675-foot deep well H-9bR at 42 gallons per minute continuously for 21 days, monitoring pressure responses in dozens of observations wells from 1.25 to 15 km away over several months. Observed drawdowns clearly indicate aquifer connectivity and validate our conceptual understanding of the most permeable formation overlying WIPP, which EPA requires consideration in repository performance assessment of future human intrusion scenarios. (6200) ECIS

Global security

Sandia's Global Threat Reduction Initiative (GTRI) secured 60 domestic and 22 international facilities storing at-risk radioactive materials, installed 66 in-device delay upgrades to increase time required to access irradiation sources, and accomplished sustainability work in 17 countries. These activities provide physical security enhancements at both domestic and international civilian sites and are key to the goal of protecting large radioactive sources and nuclear material. (6800) IHNS



SANDIA'S GLOBAL THREAT Reduction Initiative secured 60 domestic and 22 international facilities storing at-risk nuclear materials.

Sandia in partnership with LANL, Oak Ridge and DOE NA-253 hosted a Chinese delegation in support of the development of China's Nuclear Security Center of Excellence (COE). The group reviewed conceptual designs for the physical security, secure transportation, and material control and accounting elements of the COE. The meeting with the high-level Chinese delegation helps to solidify the US/China relationship across the entire Chinese nuclear enterprise. The delegations will meet again in August. IHNS



BUILDING A PARTNERSHIP with China in nuclear security.

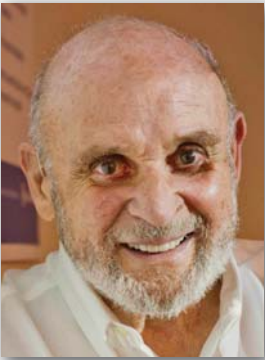
Sandia and NNSA worked with China's Customs organization to establish the Radiation Detection Training Center in Qinhuangdao, China, to prevent the illicit trafficking of nuclear material. Sandia staff oversaw the design, construction, and testing of the system, which included vehicle and personnel portals, airport luggage detection systems, and portable detection systems. IHNS

Sandia President and Labs Director Paul Hommert and Div. 6000 VP Jill Hruby participated in a meeting between directors from Russia's State Atomic Energy Corporation, ROSATOM, Sandia, Los Alamos National Laboratory, and Lawrence Livermore National Laboratory, in a continuation of a series of meetings

designed to promote scientific and technical collaboration on peaceful uses of nuclear energy. The meeting included a summary of the past year's engagement activities, an outline of future plans, a prioritized list of joint research topics, and tours of certain Russian facilities. IHNS



SANDIA LEADERS AND COUNTERPARTS from Los Alamos and Lawrence Livermore national labs met with a delegation from Russia's State Atomic Energy Corp. to promote scientific and technical collaboration on peaceful use of nuclear energy.



PAUL COOPER

Paul Cooper retired from Sandia in January 1997 after about 33 years as an explosives engineer. After retirement, Paul continued under contract as an instructor for Explosives Engineering & Technology training classes. Paul led in shaping Sandia's explosive training program for 35 years and significantly contributed to employee professional growth in this area. Paul's class notes evolved into the book

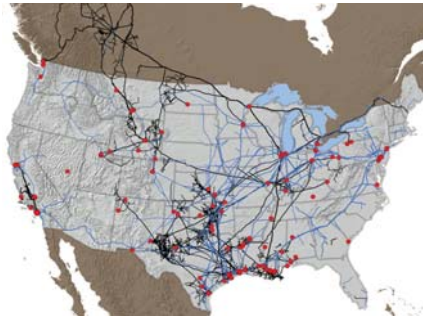
"Explosives Engineering", which he began writing in 1982 and was published in 1996. To date, this book is still the definitive text on explosives, used in university and industrial engineering programs worldwide.

After 35 years as an instructor, on May 24, 2012, Paul taught his last class and transitioned that role to Alex Tappan, Jerry Stofleth, and Venner Saul. He continues at Sandia as a consultant and mentor in Explosives Engineering & Technology.

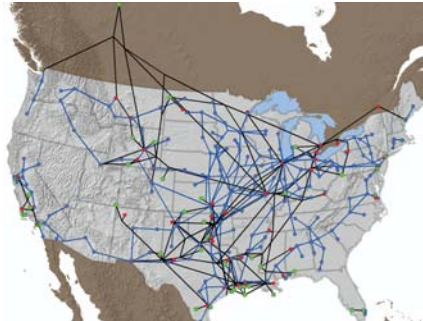
Infrastructure security

Sandia conducted vulnerability assessments including blast effects analyses and cyber security evaluations at six US Mint facilities for the Department of Treasury. These facilities were located in Philadelphia, Pa., West Point, N.Y., Denver, Colo., San Francisco, Calif., Fort Knox, Ky., and Washington, D.C. These facilities manufacture and distribute circulating coins, precious metal and collectible coins, and national medals across the nation. The US Mint also maintains physical custody and protection of the nation's gold and silver assets. (6600, 6500, 5600) IHNS

The National Transportation Fuels Model is a network fuels model to help analysts understand impacts of system disruptions for crude oil and refined product throughout the US. Since its completion in February 2012, the model has served multiple and high-profile successes: analysis to support congressional testimony in the Marcus Hooks refinery closures, development of a working model of Iraq's oil network for DOE, analysis of pipeline security prioritization schema for the Transportation Safety Administration, and impact analysis of the California refinery fire. (6900, 6600, 6100) ECIS



Map of data of actual system



Network model representation

THE NATIONAL TRANSPORTATION FUELS model is a network representation of the actual petroleum supply system in the United States.

Energy

Sandia is supporting the Western Electricity Coordinating Council and the Electric Reliability Council of Texas in evaluating where water might limit future expansion of the power grid in the western US. Working with the Western States Water Council, the availability and cost of five different sources of water have been mapped for more than 1,200 watersheds in the West. Alternative sources of water include surface water, groundwater, abandoned water rights, municipal waste water, and brackish groundwater. Results are guiding the design and placement of new electric power plants in the West. (6900) ECIS



HEADWATERS OF THE RIO GRANDE, one of the many watersheds in the West. (Photo by Randy Montoya)

After producing the safety analysis in FY10 that led to launch approval for the nuclear battery on the Mars Science Laboratory, the Sandia launch safety team supported the launch itself in FY11 at NASA Kennedy Space Center/Cape Canaveral Air Force Station as part of the Radiological Contingency Planning effort. If an accident were to occur, Sandia was at the ready to provide real-time estimates of a potential radiological release and to provide real-time reentry estimates if an earth-escape trajectory was not achieved. (6200, 1500, 5400) ECIS



SANDIA PROVIDED THE SAFETY ANALYSIS that led to launch approval for the nuclear battery on the Mars Science Laboratory. (NASA Photo)



STANLEY ATCITTY

Mentoring in the American Indian community is an ongoing passion for Stan. He has made numerous presentations to college-bound high school students and entry-level college students, sharing information about his experience as a successful American Indian professional. He received the 2007 American Indian Science and Engineering Society Technical Excellence Award for his American Indian community involvement and technical achievement. Stan was featured in a middle school-level children's science book titled *Energy Basics — Energized!* published by Sally Ride Books in 2012, giving him another unique opportunity to reach additional students.

Stanley Atcitty (6121) was selected as recipient of a Presidential Early Career Award for Scientists and Engineers (PECASE) in July 2012. This is the highest honor bestowed by the US government on outstanding scientists and engineers who are early in their independent research careers. The award recognizes Stan's advances in power electronics, as well as his dedication to mentoring in the Native American community. As a principal member of Sandia's technical staff, Stan provides technical management for the power electronics part of the Energy Storage Program, which has gained international recognition for its state-of-the-art research and development under his leadership. Stan also has received four prestigious R&D100 awards from *Research & Development magazine* for Office of Electricity Delivery and Energy Reliability funded projects.

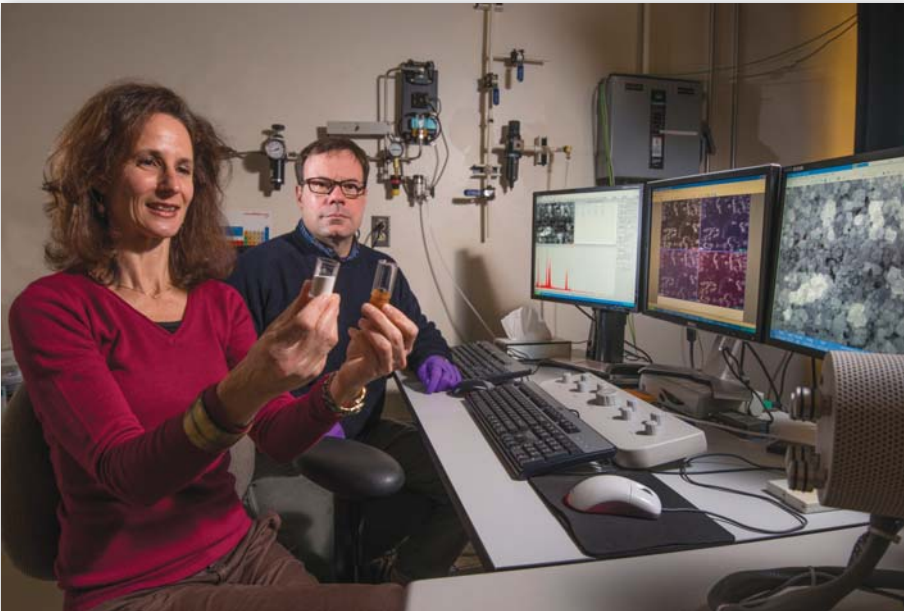
The 3rd US/German Workshop on Salt Repository Research, Design and Operations was held in Albuquerque and Carlsbad Oct. 8-11, 2012. Thirty salt research scientists from Germany and a similar number from the US met to consider the state of the art in salt repository sciences. Main topics included: 1. Readiness for the safety case for high-level waste disposal in salt, 2. Benchmark modelling of thermomechanical field-scale tests, and 3. Reconsolidation of granular salt. Effort was placed on building new collaborations and researcher-to-researcher relationships. (6200, 6900) ECIS

A newly designed high-resolution (300 MHz) spectrometer capable of recording multiple spectra sequentially with sub-microsecond time resolution having no moving parts has been built and demonstrated. The spectrometer uses two etalons (a device used in spectroscopy to measure wavelengths) of slightly different lengths to create transient frequency combs. The spectral extent of the frequency combs is set by the bandwidth of the laser used to generate them. The interference between these two combs is monitored on a single photodetector and the spectrum is obtained by analysis of the interference between the frequencies. (8300) ECIS

What happens if spent nuclear fuel stored in large pools of water for years while cooling becomes uncovered? With the support of the US Nuclear Regulatory Commission and the Organization for Economic Cooperation and Development, the Spent Fuel Pool project answered this question and provided a wealth of high-fidelity data for the validation of severe accident codes. The testing ultimately led to a cladding fire that consumed all five full-scale, mock fuel bundles. These results are expected to provide better understanding to prevent such accidents. (6200) IHNS

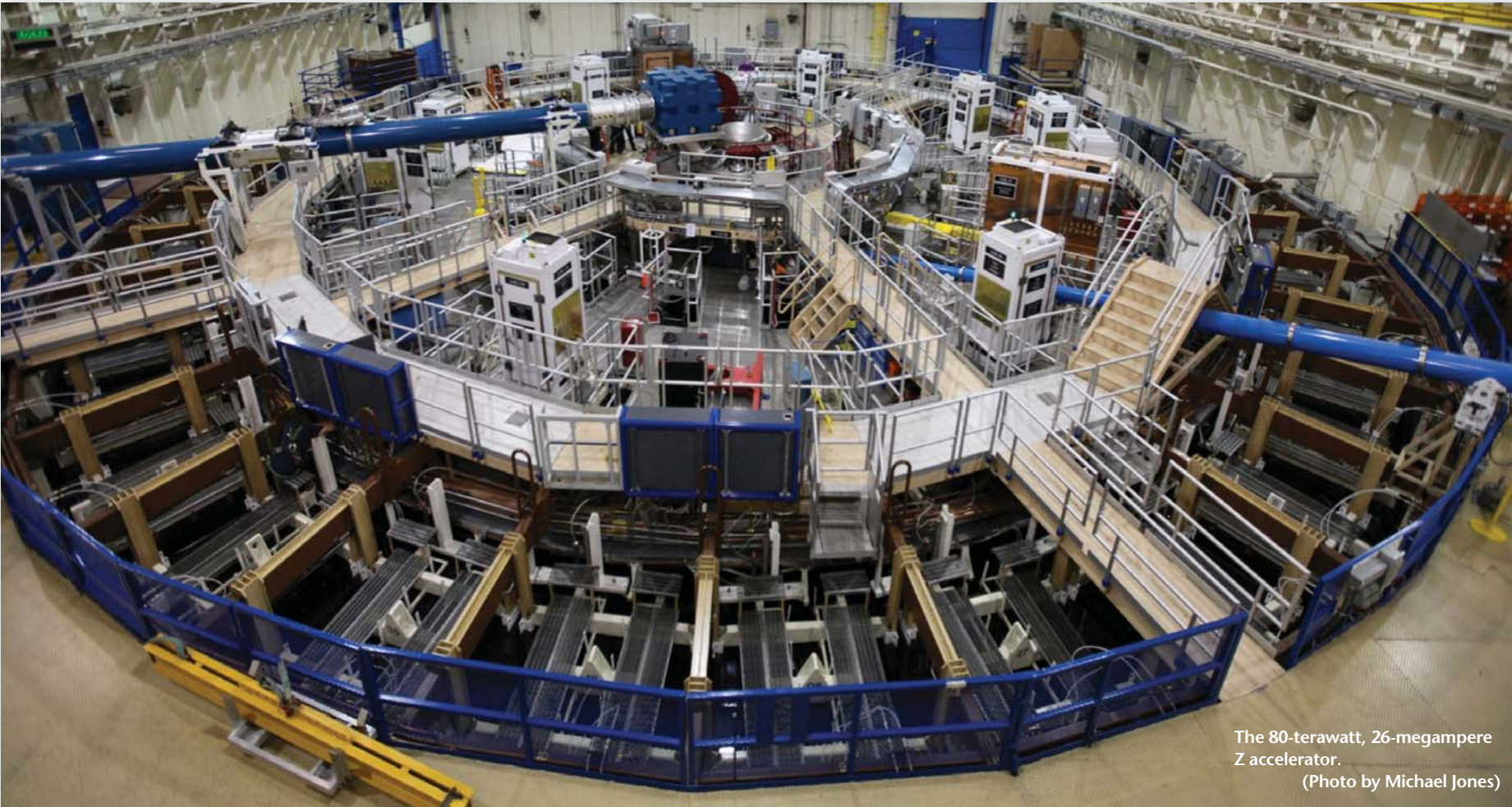
Fifteen years ago, researchers at the Combustion Research Facility used laser and optical diagnostics to develop a conceptual model for conventional diesel combustion that became the "textbook" understanding throughout the world. Nowadays, modern diesel engines often run very differently, using partially premixed low-temperature combustion to achieve lower pollutant emissions. Recently, a new conceptual model has been proposed that clarifies the differences between conventional and low-temperature combustion. This new conceptual model provides the science base needed to help the domestic transportation industry design the next generation of engines. (8300) ECIS

RESEARCHER TINA NENHOFF (below) and Jim Krumhansl (ret.) were able to demonstrate the superior effectiveness of CSTs to capture radioactive cesium in a saltwater environment. The technology is being used in the Fukushima clean-up effort. (Photo by Randy Montoya)



Crystalline Silico-Titanates (CSTs) are materials designed by Sandia scientists to selectively capture radioactive cesium. When the earthquake struck Japan in 2011, leading to the Fukushima nuclear power plant accident, it was determined that CSTs would be an excellent material to remove radioactive cesium from the contaminated seawater used to cool the plant's reactors after the accident. Quick action by Sandia and UOP, a Honeywell Company, led to licensing and deployment of CSTs to Japan. To date, more than 43 million gallons of cesium contaminated seawater has been treated using Sandia-developed CSTs manufactured by UOP. (1900, 1100, 6900) ECIS

Pulsed power

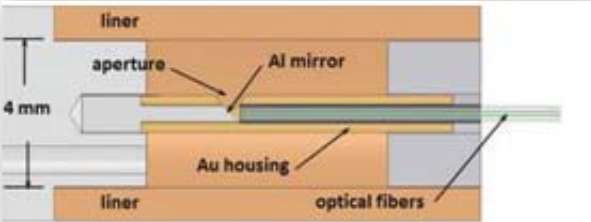


The 80-terawatt, 26-megampere Z accelerator.
(Photo by Michael Jones)

We increased the shot rate of the 80-terawatt, 26-megampere Z accelerator by a factor of two over the past five years. The rate was increased while simultaneously achieving 1 percent output-pulse reproducibility even though the complexity of Z experiments increased substantially. Z provides data on inertial confinement

fusion, astrophysics, weapon effects, radiation physics, and behavior of materials such as plutonium and uranium to support DOE programs. The increased shot rate was enabled by numerous enhancements to Z implemented since 2007. (1600) NW

Sandia developed a diagnostic, called a radial photon doppler velocimeter (PDV), to measure material properties at pressures up to 15 megabars (15 million atmospheres). Using a small optical probe and turning mirror, the inside of a metal tube can be tracked as it is compressed magnetically on the Z accelerator. In a recent experiment, we observed shockless implosion of a beryllium tube from 0 to 46 km/s (over 100,000 mph) in about 100 ns. Calculations show the pressure in the solid beryllium was 9 megabars. (1600) NW



SIDE-ON VIEW OF CYLINDRICAL LINER (or metal tube) with the internal radial PDV diagnostic. The probe that houses the optical fibers and mirror is no more than 1 mm in diameter.

The Castor subcritical experiment was executed Aug. 29, 2012, jointly with Los Alamos National Laboratory and National Security Technologies at the Nevada National Security Site. To prepare for the experiment, Sandia, in collaboration with NSTec and LANL, disassembled, refurbished, rebuilt, and optimized the dual-axis Cygnus radiography system. (In 2003 the intent was to use Cygnus only once.) The Cygnus sources provided two high-resolution, time-resolved flash X-ray radiography images. Together with velocimetry data, the outcome is the most accurate and complete data set of its kind to date. (1600, LANL, NSTec) NW



THE CYGNUS DUAL-AXIS radiographic accelerators.



As part of a Labs-wide rebranding campaign, Sandia launched a redesigned external website, developed a complete set of corporate graphic standards, and issued the *Sandia Perspectives* digital publication, which strongly supports recruiting. The renewed <http://www.sandia.gov> establishes a modern, easy-to-use presence for Sandia and is the first fully responsive .gov website that provides seamless access between desktop, tablet, and smartphone browsers. The site garnered positive feedback from across the complex and increased traffic and visits from mobile devices. In social media Sandia passed more than 10,000 followers on Twitter. (8900, 3600, 8500, 9500, 9300, 1900, 10200, 3500, 5200) ALL SMUs

ES&H & security

With support from NNSA and Defense Nuclear Security (DNS), Sandia removed the remaining no-defined-use (NDU) plutonium-bearing mixed oxide (MOX) fuel. This investment ultimately yields about \$2 million in annual security, safety, and operational savings and reduces risk from both a nuclear safety and a security perspective. (4200) IMS

After processing the remaining contact-handled transuranic waste from the Lovelace Respiratory Research Institute, a vial of curium nitrate salts remained. This presented a significant inhalation and external dose hazard to personnel. A clever solution was developed to safely repackage the vial of curium into a LANL special-form capsule in a glove box at the Radioactive and Mixed Waste Management Facility, and then to ship the package to Oak Ridge National Laboratory for re-use. (4100, 1300, 10200, LANL, ORNL) IMS

The Security System Replacement Program (SSRP) included the development, design, installation, and implementation of a large complex security system comprising multiple subsystems that required the integration of multiple locations and systems into a unified whole. Execution of the SSRP was completed a year ahead of schedule and resulted in a \$26 million cost avoidance. System reliability has also been significantly improved. (4200) IMS

The LiveSafe library of safety-related materials was launched during the spring of 2012. The collection of photos, videos, scenarios, and relevant documents and links, grouped into topical areas, is intended to be used as a resource for managers when conducting safety discussions with their staffs and for individuals interested in broadening their awareness of safe behaviors at work and at home. (4100) IMS

Governance, leadership, & management

The first-ever assessment of Sandia's Laboratory Directed Research and Development (LDRD) Program resulted in overwhelmingly positive external feedback. The Sandia Research Advisory Board, made up of distinguished academic, industry, and government experts, conducted the review at the request of the Chief Technology Officer. The comprehensive report commended the quality of the science and the researchers and research alignment with the Laboratories' current and future missions. The assessment was provided to DOE/NNSA LDRD leadership and to the Sandia Site Office. (1900) All SMUs



SANDIA'S LDRD PROGRAM garnered high praise from a review panel for the quality of its science and the caliber of researchers. (Photo by Randy Montoya)

Members of the Ethics and Business Conduct, Human Resources, and Information Technology organizations developed a SharePoint case management system that enables Sandia's investigative functions to store case information in one location. In addition to serving as a depository for all reports and supporting documentation, the system allows for rapid retrieval of all historical data and enables the investigative functions to accurately track cases and respond more efficiently to requests related to employee conduct. (00800, 3000, 9500) IMS



JENNIFER PLUMMER

Jennifer Plummer, director of Independent Audit, Ethics, and Business Conduct (800), took the lead in FY12 in reinvigorating a group that is instrumental in enabling Sandia management to make informed decisions and develop appropriate corrective actions. Jennifer presides over the Business Conduct Working Group, which comprises representatives from several Sandia functional areas: Ethics, Corporate Investigations, Legal, Counterintelligence, Diversity, Employee and Labor Relations, Security Incident Management Program, Cyber Security, Ombuds, and Human Resource Business Partners in New Mexico and California. "We share information about processes, risks, best practices, and trends. We communicate concerns and solutions to management," Jennifer says. "We developed and accomplished a set of goals for FY12, including development of a common-case management system and defining roles and responsibilities across the investigative bodies and HRBPs, and we have developed FY13 goals." Jennifer reinvigorated the team early in the fiscal year. The team's success is attributed to a strong partnership across the functions and the team's commitment to a learning, inclusive, and engaging environment for our people (Strategic Objective 5). Deputy Labs Director and Executive VP for Mission Support Kim Sawyer says the Business Conduct Working Group has been instrumental in providing guidance and counsel to Sandia's investigative areas and in identifying trends and weaknesses.

On Sept. 28, 2012, Paul Hommert signed an extension of Sandia's management and operating (M&O) prime contract between Lockheed Martin and NNSA/DOE. The prime contract was extended through Sept. 30, 2013, with two three-month options for a total possible extension of 18 months. This extension provides continuation of the current prime contract during the contract re-compete and award process. Lockheed Martin has held the prime contract since 1993. (10010) ALL SMUs

Independent Audit, Ethics & Business Center 800 performed three Site Management System assessments to evaluate specific ES&H programs at Sandia. The assessments were previously done by the Sandia Site Office's ES&H (SSO/ES&H) organization. Center 800's performance of the assessments under SSO/ES&H review aligned with Sandia's Strategic Objective 3 of governance reform leading to increased efficiencies. The joint effort has led to more efficient use of personnel at Sandia to conduct assessments and SSO/ES&H to provide oversight. (800) IMS

The Mission Support & Corporate Governance Center worked with programs, divisions, and policy areas to improve assurance processes in support of Sandia's Strategic Objective 3: Lead the complex as a model 21st century government-owned, contractor-operated national laboratory. From the assurance maturity baseline established in FY11, Sandia met its FY12 target to demonstrate improved assurance implementation at Level 3 ("repeatable") maturity. Sandia's assurance processes are a fundamental part of establishing and maintaining confidence that Sandia delivers high-quality results consistently and predictably. (700) All SMUs



JO CUNNINGHAM

Jo Cunningham has demonstrated success in the performance of her job duties as a Prime Contract administrator at the distinguished level for Sandia Corporation, the management and operating contractor for Sandia National Laboratories. Her recent performance that warrants nomination for the Blanche Witte Memorial Foundation Award, a national award for recognition in the field of contract management and procurement, includes investigation and resolution of significant cost allowability issues, mentoring a distinguished graduate of the National Contract Management Association (NCMA) Contract Management Leadership Development Program, acting as past president of the NCMA Rio Grande Chapter, and making substantial contributions to the extension of Sandia's prime contract. Jo is a team player who puts others ahead of herself. She has demonstrated willingness to go the extra mile in exceeding established objectives and expectations through her "can-do" attitude. Jo joined the Sandia staff in 1989 and has spent her career in supply chain management and corporate contract management. She earned an undergraduate degree in Asian studies at the University of Colorado and a master's degree in procurement from Webster University.

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Division 10000, in partnership the SMUs and Division 9000, completed a new cost-estimating tool and accompanying procedure. Anthony Medina was a key lead and champion of the effort. The new approach incorporates a technical basis for estimates; clarified cost-estimating roles and responsibilities; defined cost-estimating process flow from initiation to closeout; and refined process steps to develop a rough order of magnitude, budgetary, and definitive estimates. The new tool supports and enables this approach. Labs-wide training activities were developed to support implementation of the tool. (10000, 9000) All SMUs

In September 2012, about 150 Sandians working in Mission Support organizations were assigned through functional alignment to other divisions and centers that better fit the jobs they do. The initiative pulls together people with common capabilities, ties, interests, and professions for better collaboration. Functional alignment provides more customer-focused service, leverages expertise, reduces bureaucracy, fosters greater consistency in implementing policies, and makes operations more cost-effective. It also ensures employees with similar skills get the support and training they need to do their jobs. IMS

Community involvement, customer relations, institutional development

Labs employees and retirees made history when Sandia became the first company ever to donate \$5.5 million in a single campaign to the United Way of Central New Mexico. As of November 2012, the Labs' Employee Caring Program had collected \$5.2 million for United Way with total giving up 13 percent over the previous year's record-breaking \$4.6 million contribution. The final numbers went even higher as more retiree donations came in during December. Sandia's overall participation rose to 73.6 percent, up from 71.8 percent last year. (All Sandia)



CLIENTS OF THE STOREHOUSE in Albuquerque, a food and clothing bank, supported in part through donations by Sandians, shop for groceries and other necessities. (Photo courtesy of The Storehouse)

LIFT OFF — A target missile is launched into the night sky from a vertical launcher at Sandia's Kauai Test Facility. The target was shot down by the Navy's newest interceptor missile. KTF observed its 50th anniversary in 2012.
(Photo by Scott Walkington)

See more on page 10.

